

The Life History of Certain Moths of the Family Cochliopodidæ, with Notes on their Spines and Tubercles.

By A. S. Packard, Providence, R. I.

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I am under special obligations to Miss Emily L. Morton for the eggs of several species of this family, which gave me the opportunity of rearing them and thus of observing the freshly hatched larvæ of species of three genera of this most interesting group, none having heretofore been described, unless we except a very brief notice in Buckler's *Larvæ of the British Butterflies and Moths* (iii, 76) of the freshly hatched larva of *Heterogenea asella*, as follows: "As well as my strongest lens would show them to me, these very small specks of creatures were of an ovate, roundish figure, dark brown above and pale greenish beneath—in short, miniature representations, apparently, in all respects of the mature larva."

I was very eager to learn whether the freshly hatched larva of any of this group was born in the form of the fully grown larva, and entirely without abdominal legs, or whether its body might not be more generalized in shape and structure and with the vestiges at least of such legs. The result appears to be that, the young larvæ are, so far as known, without traces of abdominal legs, and that while those of the more specialized though primitive genera, as *Adoneta* and *Empretia*, are born with the tubercles already nearly as much specialized as in the full-grown larva, in the more modified genus *Lithacodes* (*L. fasciola*), the body is much more cylindrical and simpler, and thus more modified than in the foregoing genera, being without tubercles, but with forked glandular setæ.

Another result of great interest is that the shape of the young larva of *Adoneta* and also of *Empretia*, with their large tubercles bearing three radiating setæ or bristles, is such as to remind us of the larvæ of the Saturniidæ, and to suggest one of two alternatives, viz., (1) either the Cochliopodidæ have originated from the Saturniidæ or forms allied to them; or (2) both the Saturniidæ and Cochliopodidæ have descended from a common stem-form, and this perhaps some Notodontian.

At all events the systematic position (and in this connection I may say that the pupal and imaginal characters bear me out) of the group represented by *Lithacodes* and its allies is very near the Saturniidæ, and not far from the Notodontians. It would seem as if the oldest, most generalized, or less modified forms, viz., the original ancestors, were the tuberculated larvæ of *Euclea*, *Adoneta* and *Empretia*, as they are more like the larvæ of other Bombycæ, particularly the Saturniidæ and Notodontians. On the other hand the nearly smooth slug-worms, without hairs or tubercles when fully grown (such as *Lithacodes* and *Heterogenea*), seem to be the most aberrant and modified, viz., have become the most adapted to the peculiar mode of larval life emphasized by the term "slug-worm;" these

being caterpillars which have lost by disuse their abdominal legs, the thoracic ones being greatly reduced in size, while by their sluggish disposition, by their slug-like, slow gliding mode of progression, and by the peculiar coloration of such forms as the larval *Heterogenea*, which mimics the red, swollen spots on the leaves of various trees, particularly the oak, chestnut, wild cherry etc., we have, as the result of gradual modification brought about by adaptation, perhaps the most strange and bizarre type of Lepidopterous larva in existence.

Thus, as a result of adaptation, probably brought about by a series of causes unlike those affecting any other caterpillars, we have larvæ which, as in that of *L. fasciola* and also the larvæ of *Packardia*, are entirely green, oval in form, and which we have noticed might easily be mistaken for a fold or bend in a leaf. These smooth-bodied, unarmed slug-worms are protected (1) by their oval shape, the expanded edges of the body appearing to merge into the surface of the leaf; (2) by their sluggish almost imperceptible gliding motions; (3) by their pale pea-green ground color, with faint yellowish or reddish shadings on the more exposed ridges and projections of the body. These and other wholly green ones may have been eliminated during the struggle for existence from the earlier, tuberculated genera by their resemblance to green galls or swellings on the surfaces of leaves. That the larvæ of *Heterogenea*, such as *H. flexuosa* and *H. testacea*, are wonderfully similar to the red dipterous or aphidid galls on oak and other leaves was first suggested to us by the late Mr. S. Lowell Elliott,* and since then we have frequently verified his observations, and been struck with the wonderful resemblance between these larvæ and the small reddish and greenish galls which appear late in summer on the leaves at the time when the larvæ themselves become fully grown. These forms being thus protected from observation and harm, do not need the armature of the other group, the tubercles and spines have disappeared through simple disuse; while being without poison-bearing spines, they have also lost by disuse the bright colors and conspicuous spots of the armed genera. On the other hand, the larvæ of *Adoneta*, *Empretia*, *Euclen* and allied forms, with their remarkably bright colors and markings, and poison-bearing tubercles, feed conspicuously, the warning colors and showy ornamentation repelling the attacks of birds. We are inclined to the belief that the armed slug-worms were the earlier, from the probability that in the *Coleoptera* the earliest and most generalized groups were the *Staphylinidæ*, and the carnivorous *Carabidæ*, and allies, while the later, most extremely modified forms were the *Weevils* and *Scolytidæ*, in which the larvæ are footless. In the *Diptera* also it is not improbable that those families with the most perfectly developed larvæ, such as the *Culicidæ*

* Compare the remarks of Mr. Poulton on the meaning of the peculiar method of progression in the larvæ of *Cochliopodidæ* in *Trans. Ent. Soc. of London*, 1888, 591, wherein he states that Mr. Tate could not remember any object which the larvæ of *H. asella* resembled. Mr. Poulton remarks that they "may suggest the appearance of some kind of gall on the surface of the leaf."

and Tipulidæ, were the earliest and most generalized types, while the Muscidæ, with their apodous maggots present the extreme of modification though not of specialization, and so with other apodous insects and apodous Arthropoda in general.

To return to the Cochliopodidæ: the great difference between the tuberculated and spinose and the smooth, unarmed genera show that the forms were more or less plastic, and though all of them are born without abdominal legs, yet after atrophy had taken place, the larvæ of different genera became exposed to quite different surroundings and stimuli, and responded to such varied changes with the result seen in the numerous genera characterizing the eastern regions of North and South America, as well as Southeastern Asia; Europe only possessing two species, and none being yet known from the Pacific slope of North and South America.

It will, of course, be a matter of great interest to examine the embryos of this family in order to determine how late in embryonic life the abdominal legs disappear, for, undoubtedly, as in the embryos of such Lepidopterous larvæ as have been examined by embryologists, each segment bears a pair of temporary embryonic legs. Probably the legs are represented by the transversely oval ventral areas or muscular folds on each segment of the abdominal region in the slug-worms.

As a result of studies with larvæ and moths I may add that the genus *Heterogenea* is more largely represented in the United States than formerly supposed, and the genera *Kronea* and *Tortricidia* are with little doubt synonyms of *Heterogenea*, the characters which I originally employed not being of generic value.

THE LIFE HISTORY OF EMPRETIA STIMULEA CLEMENS.

I am indebted to Miss Emily L. Morton, of East Windsor, N. Y., for the eggs of this interesting form. The larvæ hatched July 9 to 12 at Brunswick, Me., from the eggs sent a few days previous.

Egg.—As usual in the family, an irregular, oval, flattened, scale-like body, with a very thin edge; under a half-inch objective the shell is seen to be thin, transparent, and without any markings. They are laid in an irregular mass, partly overlapping each other. Length, $1\frac{1}{2}$ to 2 mm.; breadth, 1 mm.

Freshly Hatched Larva.—Length, 1.2 mm. The body is broad and high, about three times as long as high, but much more cylindrical than in the full-grown larva. The head is pale and the body is pale straw-yellow. The eyes are black and distinct. The prothoracic segment is large, somewhat hood-like, not bearing any visible tubercles, but with two obsolete warts, giving rise each to three hairs. The other segments are in this stage distinctly marked, especially dorsally and ventrally. On each of the second and third thoracic, and the first abdominal segments is a pair of high conical tubercles, which are moderately thick at base, and nearly as long as one-half the thickness of the body, each giving rise to but three

setæ, which on the average are about three-fourths as long as the tubercles; *the first (mesothoracic) pair are as large as the second and third, all being alike in shape, length and size* (Fig. 1).

Succeeding the three pairs of large high tubercles are five pairs (on segments 2 to 6) of tubercles which greatly contrast in size with those at each end of the body, being very much smaller, only about one-third as high as the others, or about one-half as high as the others are thick in their middle. On the end of the body are three pairs of large tubercles, the first pair of these (on abdominal segment 7) being larger and thicker than those on the thoracic and first abdominal segments; those of the pair on the eighth segment are about as large as the pair in front, but those on the last pair (on the ninth segment) are about one-half as large and long as those on the eighth segment. They all bear only three setæ each.

The setæ or hairs appear under a half-inch objective to only taper like a simple seta, the tip, however, not being acute, neither very blunt; but under a higher power ($\frac{1}{3}$ obj. A. eyepiece), the points are seen to be divided or forked, but with only two divisions. Fig. 2 represents a tubercle highly magnified, showing the finely forked glandular setæ, each of which is moved by a retractor muscle (*m*).

Larva. Stage II.—Length, 5 mm. The three anterior pairs of tubercles are paler, the largest (hinder) thoracic pair much darker reddish purple. Between the first and second dorsal pair of tubercles are two parallel dorsal rows of three pale dots, forming two short parallel broken lines. A yellow spot between the two larger tubercles, and in front is a fine transverse line connecting two yellow dots, and a similar smaller mark behind the yellow spot. Threesimilar marks, *i. e.*, a yellow median spot and two transverse lines at the base between the abdominal tubercles. The brown-and-white edged lines nearly enclose each set of tubercles as before. The body is green and straw or lemon color above, and greenish amber low down on the sides.*

Stage III (?).—(July 23.) Length, 6 mm. The ten anterior fleshy appendages are all pale lilac; those in front the paler; the second dorsal pair about one-third larger than the first pair, and the third pair about one-third larger than the second, and nearer together at their base; the latter are deeper purple, and are dark at the end. The large pair near the end are also purple, and only slightly larger than the second anterior

* Miss Mulfeldt thus describes the young, probably in Stage II, as she observed them at St. Louis: "Late in August of the present year I found quite a colony, probably ten or twelve, on a single leaf of the above-mentioned tree. They had but recently hatched, but they as they were—not more than an eighth of an inch in length—they had all the tubercles and other characteristics of the mature larva, except that the saddle-cloth-like spot was deep yellow instead of green and the central dorsal spot pinkish gray. They had perforated the leaf with small irregular holes. Not thinking that they would readily loosen their hold on the leaf, I carried it carelessly in my hand, and when I reached the house was much disappointed to find that but two larvae remained on it. As these thrived and perfected their development to the point of enclosing themselves in cocoons, it is evident that maple may be included in the list of their food-plants" (*Bull. Div. Ent.*, 13, 68).

pair. The small pair of dorsal ones near the end are greenish yellowish. The two lateral ones in front on each side are about three times as large as the eight on each side behind them, and they are purplish, while those (the eight) behind are pale greenish.

On the back, behind the first pair of appendages, are two parallel purplish longitudinal patches, with the pale whitish median line between them, and behind them are two dark patches, also separated by the median line. Between the second and third pair of appendages is a transverse dark brown stripe, which passes around behind the appendages but does not meet behind, and behind it is a roundish yellowish median patch; behind this patch, between the bases of the two appendages, is a short transverse white line. The tip of the body behind is lemon-yellow, and on the second, third and fourth segments behind the third pair of appendages is the saddle-like median spot. It has a median oblong lilac-brown patch, bearing two transverse broken white short stripes edged with brown. On each side of this patch is a white border with three scallops externally, and edged with black, the black line forming three scallops. The two large purple posterior appendages are partly surrounded at base by a brown curved line, the two not meeting in front or behind, and between the bases of the long conical fleshy tubercles are two linear dark stripes. The rest of the body is pale greenish, with a slight yellowish tint. The appendages have each slender purplish spines of quite even length. It is bright colored and showy, and must depend on its spines for immunity from attack.

It feeds in this stage on the upper surface of cherry leaves, eating off the surface, leaving large dark patches. Crushed one of the small ones, and found the hairs painful and annoying to my hand.

Stage III or IV (?).—Length, 7-8 mm. The thoracic segments—*i. e.*, all the region bearing the anterior tubercles or papulæ—is now dark reddish brown; the third, or hinder thoracic tubercles, dark reddish brown, and the yellowish dots and lines are obsolete, only the bright yellow spot behind the third pair of thoracic tubercles being left. The two anterior pairs of tubercles are much paler than the third pair and the pair on the eighth abdominal segment. The last pair on the end of the body are pale amber. The lateral papulæ or tubercles are still green. The yellow dorsal region between the thoracic and abdominal papulæ is now yellow, edged with white on the side low down, and in front and behind are white borders edged part of the way with dark reddish brown. In front of and behind the "saddle" are two twin dark dots. The saddle is plain brown, oval, cylindrical, bordered with white, which is edged within with rosy, and, on the outer edge, with dark brown, this border being interrupted in front and behind, opposite the twin dark dots. All around, and at the base of the large tubercles on the eighth abdominal segment, the back is dark reddish brown with a median yellow spot, and behind on the next segment are two large oblique oval white spots, meeting on the middle of the body, and faintly tinged with lemon-yellow.

Full-fed Larva.—Length, 20 mm.; breadth, 7 mm. The body is very thick and stout, nearly one-half as long as broad, the dorsal surface regularly convex, being well rounded above, a little wider in front than behind. The prothoracic segment, with no tubercles, forming a hood for the head, which is dull amber colored with darker spots. The second thoracic segment with four spinulose fleshy conical tubercles, the dorsal ones slightly larger than the lateral ones. Similar ones on the third thoracic segment, but they are a little larger. On the first and eighth abdominal segments are two very large diverging horn-like processes, and armed with coarse spinules, which like those elsewhere are simple, ending in a slender, stiff corneous black point. On the last segment is a pair of small tubercles and a terminal pair of rust-brown flattened branches of singular spinules. The body is rust-brown, with a livid hue, and the skin is granulated. Abdominal segments 2-7 are pea-green, bordered below with a white lateral line, and enclosing a large dorsal round brown spot bordered with whitish. Between the base of the horns is a small pale spot, and behind are two nearly adjoining yellowish-white patches.

The shape of the stout spines on the tubercles of the full-grown larva is represented by Fig. 3, *a*, which is, however, one of the smaller spines. A singular spine is represented at Fig. 3, *b*; it is clavate, and arises from a papilla situated on the middle of the tubercle near the edge; such clavate setæ as these are very rare, the only other one observed was situated on the middle of another tubercle below the group of papillæ, which extends to the end of the tubercle. A very remarkable spine, and one which we believe is largely concerned in producing the poisonous and irritating effects resulting from contact with the caterpillar of this species, is one situated in scattered groups near the end of the tubercles. A group of three is represented at *e*. They are not firmly embedded in the cuticle, but on the contrary appear to become very easily loosened and detached, and they probably, when brought into contact with the skin of any aggressor, burrow underneath, and are probably in part the cause of the continual itching and annoyance occasioned by this creature. It will be seen by reference to Fig. 3, *e'*, that the body of the spine is spherical with one large elongated conical spine arising from it, the spherical base being beset with a number of minute, somewhat obtuse spinules. This spine reminds one of an old-fashioned caltrop, and a group of them constitutes a formidable armature. The cuticle at the end of the tubercles is granulated, each fine projection being the end of a vase-shaped papilla, all being closely crowded together, as at *c*. The skin of the body between the tubercles is seen to be finely shagreened, an appearance due to the presence of fine clear teeth more or less curved and bent, which arise from a very finely granulated surface, as at *d*. It will thus be seen to what an unusual extent the differentiation of the spines and of the armature of the cuticle itself is carried in this highly specialized form.

Miss Murtfeldt has called my attention to the variation in the larvæ in the length of the tubercles, in the intensity of coloring, and the presence or absence of the cream-colored spots.

RECAPITULATION OF THE MORE SALIENT ONTOGENETIC FEATURES.

A. *Congenital Adaptational Features.*

1. The tubercles on the second and third thoracic and the first, seventh and eighth abdominal segments three times the size of those on abdominal segments 2-6; these tubercles being already differentiated at birth and more markedly so than in *Adoneta*.
2. Head not capable of being withdrawn into and concealed by the prothoracic segment.
3. The tubercles each bear only three two-forked glandular setæ.
4. The body is more cylindrical than in the later stages, and colorless.

B. *Evolution of Adaptational Features.*

1. In Stage II the form and general colors of the full-fed larva are assumed.
2. The tubercles are now armed with numerous poisonous spinules.

Note.—From what we now know of the congenital, as compared with the later acquired adaptational characters of *Cochliopods*, it is evident that the latter are acquired at an earlier stage than in most other caterpillars.

LARVA OF *EUCLEA QUERCETI* (H. S.) (MONITOR PACK.).

The following description is based on over a dozen individuals, found from August 25 to September 8 at Brunswick, Me., on the red or swamp maple and the beech, most abundantly, however, on the former, and always on the under side of the leaves.

Last Stage.—Length, 18 mm.; breadth, 5-6 mm.

The outline of the body seen from above is regularly elliptical, each end being alike. Body with a broad dorsal, flat, plateau-like surface, not so wide as the body, extending from one end to the other, and bearing a row of high conical papilliform tubercles of unequal size. From this plateau-like surface the sides of the body fall away nearly vertically down to a slight ridge bearing long slender papulæ, and situated above the edge of the creeping disk. The body is in general pea-green of two shades, a lighter and darker, with a yellowish hue, assimilating it to the color of the under side of the leaves of its food-plant.

Along the body are two dorsal rows, wide apart, of high, elongated, densely spinose conical tubercles, the spinules black on the distal half. Those of the first pair, situated on the second thoracic segment, are green; those of the second and third pair yellowish; those of the third pair are larger than the second, and the second than the first. All these tubercles are usually reddish on the distal half. On the next five segments is a pair of small rounded tubercles; the first pair, situated on the second abdominal segment, the smallest, and the third pair the largest. The ridge bearing these tubercles is orange, edged with yellow. Between the second and third pair of large anterior tubercles is a rounded madder-brown

spot, and a much larger second one between the first and second pair of small tubercles, which is a deep rust-red or brown-madder squarish or oblong patch; a similar one lies between the fourth and fifth tubercles, and a fourth smaller, more rounded one between the first and second pairs of the large terminal tubercles. At the end of the body are three pairs of high conical tubercles like those in front. The two anterior pairs are the largest, and those of the posterior pair project out horizontally backwards and are green, the others being yellowish. In the green median dorsal space is a pale median dorsal line, edged distinctly with black, and the sides of the area are edged with black, and dilate near the base of the tubercles, forming black blotches.

The outer side of the subdorsal ridge is edged with black in the same way, and this system of black marks connects with a lateral series of polygonal nearly circular black rings on the vertical sides of the body, and each enclosing two pale, depressed, oval, green areas. There is a lateral series of nine green, long, slender, pointed, spinulate tubercles. Nearly each tubercle on the upper side bears a large pale brown patch like a mass of sand (under a high-power Tolles' triplet I cannot discover the nature of this sand-like mass, which is wanting on the first two and last one). At the end of the body are four conical, high, deep black pencils of fine hairs; one between the last and penultimate subdorsal tubercle and another in front between the penultimate subdorsal and last lateral tubercle. On the first thoracic segment are a few fine hairs; it is green and not spotted. The head is green, with the mouth-parts dark. Fig. 4 represents a dorsal tubercle with its spines; it is perhaps from too old a specimen to show the unicellular poison glands at the base of the spines; *s.*, a single forked minute spinule; *ct.*, the cuticle at the base of the tubercle containing clear roundish spaces with a raised edge. There seem to be no caltrops or minute spines in the cuticle of this genus.

Two specimens living on the oak were received from New York through Mr. Simpson. One of them is colored as usual, but the subdorsal madder-brown or reddish squarish spots between the papulæ are dull and rather faint. The other, larger, is quite different in color from normal individuals. The body and dorsal papulæ instead of green are dull orange-reddish, while the reddish patches between the subdorsal papulæ are faint and smaller than usual. The network of what are usually black lines on the sides is rather reddish. The polygonal lateral areas include an upper often dumbbell-shaped pale spot, and a lower double pale spot, the oblique oval spot being supplemented by a pale dot just below and in front. The posterior black conical tuft of hairs is much larger than the lateral ones in front.

It began to spin a thin cocoon September 14.

Two full-grown larvæ, apparently of this species, were found August 1, on the back of a pear tree and received from J. H. Pearson, of Portsmouth, N. H. I will copy my description: Body oblong, flattened beneath, convex above, with a slight subdorsal ridge on each side of the

back, giving a slightly quadrilateral outline to the animal in section. It is pale ultramarine green, the fleshy conical spines or papulæ being deeper green. Of these papulæ there are two subdorsal rows, ten in a row, and otherwise as already described. The spinules of these papulæ are white at the base, with the distal end black. There is a row of lateral spines similarly spinulated and of uniform size. The four pairs of square spots are blackish, those of the anterior pair (on second thoracic segment) being rounded. They are more or less connected with dorsal irregular lines and dots. On the side of each segment is a blackish ring, lined within more or less distinctly with white, and enclosing a roundish hexagonal green spot.

Remarks.—The larvæ of the genus *Euclea* are wonderfully differentiated and specialized as to their papillæ and surface markings, as well as colors. The object of this or rather the process by which these structures and markings have gradually appeared, can, so far as we can now see, only be explained by supposing that they are warning structures and colors, the gay colors enabling the insect to be easily seen and the forbidding spines preventing their being swallowed by birds after once being detected. On the other hand, the more plain, unarmed larvæ of *Heterogenea* are instances of protective resemblance, as their lives are saved by their exceedingly sluggish movements and their green colors, assimilated to the hues of the under side of the leaves, in which they rest, for the most part nearly immovable. Yet why should *Euclea* feed like *Heterogenea* and allies on the under side of the leaf, and not on the upper, where it would be readily seen?

PARASA CHLORIS H. SCH. (P. FRATERNA GROTE).

The larva, like those of many other Cochliopods, lives on the under side of the leaf of its food-plants. It often, however, begins at the end of a leaf and eats down to the base; it remains on the under side, but the hood bends over so as to be seen from above, but the color, exactly like that of a brown sere part of the leaf, protects it. Several specimens were kindly sent me by Miss Morton, September 4.

Full-grown Larva.—Length, 15 mm. The body is oblong, square; when seen in section it is somewhat trapezoidal, the dorsal surface being flattened, though still somewhat convex, and one-half to two-thirds as wide as the creeping disk or under side of the body. Posteriorly the body ends in a long, slender, fleshy projection or "tail," which is somewhat spinose and slightly forked at the end. Along each side of the dorsal area is a row of short, thick, retractile tubercles which bear peculiar stout spines, which are whitish, tipped with brown at the ends. Fig. 5, *sp.* represents a part of one of these tufts of sharp spines, which are white, becoming dark towards the ends; *ct.*, the spiny cuticle of the body, the spinules being modified cuticular cells; *ct'*, the same seen from above. A few caltrops were to be seen. The third pair from the head is situated nearly on

the second abdominal segment, and is twice as large as the others; those on the eighth abdominal segment are much larger than the other abdominal tubercles (which are minute), and the spines on this pair are whiter than those on the other tubercles. A brown line washed externally with paler bounds the sides of the back. A lateral row of small tubercles bearing spines is situated around the edge, the middle of each tubercle being raised, convex. The spiracles are minute, white, somewhat raised, and situated in a darker round area. Low down between the two rows of tubercles is a row of smooth, kidney-shaped depressed spots. The head is chestnut, the labrum paler. The under side or creeping disk is pale flesh color edged above with a reddish stripe, becoming reddish brown above. The body above is of a rich velvety dark flesh-red brown. Some individuals are much darker than others. The under side of the "tail" is flesh colored, reddish above, and on top of a rich brown.

In this species the spiracles are plainly seen to be arranged, as in *Lima-codes scapha*, on the side of the body rather low down, but above the edge of the creeping disk.

In *P. chloris* (*fraterna* Grote) the tail-like end of the body is longer and better developed, and more movable and nutant than in the larva of Packardia. It is slowly raised and lowered while the animal is creeping, with the result that it must be deterrent to ichneumon and other insect enemies. The "tail" is quite hirsute, and is flesh-colored below and at the end, but on the upper side is brown like the body. It varies in length. The "hood" or prothoracic segment is in this species larger and freer from the second thoracic segment than usual.

On one of the larvæ was observed an oval cylindrical ichneumon egg.

LIFE HISTORY OF ADONETA SPINULOIDES HERRICH-SCHAEFFER.

Batches of the eggs of this Cochliopod were also very kindly sent me by Miss Emily L. Morton, from New Windsor; they hatched July 18 or 19. The eggs are so flat, scale like and transparent, that they must be very difficult to detect on the leaf of the food plant. Thus the eggs must be to an unusual extent free from attack of other insects or the gaze of birds, etc.

In Stage II, when feeding, the upper (never the lower) surface, says Mr. Bridgham, is eaten, and all the contents, leaving only the lower skin of the leaf, thus forming little pits on the surface.

Egg.—Very flat, rounded, oval, with very thin edges; varying much in size, some being twice as large as others, varying from 0.7 to 1.4 mm. in length, and nearly as broad as long. The cast shell is thin, membrane-like, not preserving its shape after the exit of the larva, and not showing any markings. Though the eggs themselves vary so much, yet the larvæ within are of nearly the same size. This variation in size is very unusual in insects and may be correlated with some interesting peculiarities of the oviduct.

The Freshly Hatched Larvæ.—Length, 0.8 to 1.2 mm. The body is oval, cylindrical, with both ends nearly alike. The dorsal tubercles are large, prominent, conical; those on the second and third thoracic and first abdominal segments are large, conical, and twice the size of those on the second and third abdominal segments, while those (in one of my specimens) on the fourth segment are as large as those on the first or seventh segment, but in another no larger than those on segments 2, 3, 5 and 6; those on segments 5 and 6 are of the same size as those on segments 2 and 3; those on segment 7 are as large as those on segment 1; those on segment 8 a little smaller than those on segment 7; those on segment 9 of the same size as those in the middle of the body. From each of these tubercles arise three glandular hairs or setæ, which are on the average about a third longer than the tubercles themselves; they are rather stout, tapering slowly from the base to the tip, slightly curved, and divided at the end (as seen under a $\frac{1}{2}$ objective B eyepiece) into three short minute forks.

There is a lateral row of tubercles, one to each segment, beginning with the second thoracic, which are smaller or about half as large as the smallest dorsal ones, and each bearing three setæ. The segments are quite well distinguished. The head is white, about one-half or two-thirds as wide as the body; the latter is at first pearly white, and later with a purplish shade on the back; the skin is very finely granulated, and the spines are blackish towards the tips.

Fig. 6. A camera sketch, from an alcoholic specimen, of the freshly hatched larva; both rows of dorsal tubercles are represented (author del.). Fig. 7. A restoration of the same by Mr. Bridgham, corrected by the author; *f*, front view. Fig. 8, *a*. Third thoracic dorsal tubercle (or first abdominal), bearing three spinules at the end, each terminating in three short, minute, obtuse forks; *a'*, ends of four spinules; from each fork or branch a stria passes down to the base of the spinule.

The following description of Stage II has been drawn up from a specimen stated by Mr. Bridgham (to whom I sent the eggs and freshly hatched young) to have molted once, and from which he made his Fig. 215. The drawing was made July 20, the specimen feeding on the scrub oak.

Stage II.—Length, 2.8; width, 1.4 mm. The larva is now at least three times as large as before molting, and it would be difficult (as I have not myself seen the larva alive in this stage) to believe that it could be in Stage II, unless Mr. Bridgham had noted the fact on his sketch that it was drawn “after the first molt.” The larva has now assumed nearly the shape and nearly the colors of the fully-grown larva, the tubercles even being a little larger in proportion, and with the spines as numerous and as large as in the last stage. The body is broad and flat, and the head is entirely concealed by the prothoracic hood. The skin is finely granulated. The tubercles are now completely differentiated, and are indeed a little larger in proportion to the body than in the full-grown larva.

Fig. 9 represents a small anterior lateral tubercle after the first molt; the unicellular poison cells not distinctly seen; *a*, a larger lateral tubercle.

Fig. 10, tubercles of last stage; *a*, tubercle with venomous spinules; *b*, space at the base of a tubercle densely covered with caltrop-like spinules; these caltrops are very easily loosened, and can readily work under the skin; *c*, end of a tubercle; *c'*, part of the base of a tubercle, with the granulated cuticle near the base; *d*, two caltrops enlarged; *e*, two venomous spines, with the unicellular gland in the expanded base of the spine; *e'*, a spine of different shape on the same tubercle (author del.).

The second and third thoracic dorsal tubercles are a little slenderer and smaller than the pair on the first abdominal segment. The pair on the fourth abdominal segment are nearly three times larger than those on abdominal segments 2, 3, 5 and 6; those on segments 7 and 8 are of the size of those on abdominal segments 4 and 1.

The ground color is a pale, delicate pea-green; most of the tubercles are green, but the large dorsal tubercles on first, fourth and seventh abdominal segments are now rose reddish; the others only faintly stained with roseate.

It thus appears that all the essential characters of the fully grown larva are assumed in the second stage, and at a period much earlier than in the larvæ of some, if not all, of the other Bombycine families. This acceleration of development of the adaptational characters of the larva seems to occur also in *Empretia*, and probably in *Lithacodia*, and is perhaps common to the group. Additional observations are, however, much needed on this interesting point.

The following description is drawn up from ten larvæ kindly sent me by Mr. Fred. B. Simpson from New York. It feeds on japonica, and will, he says, eat the wild rose.

Stage III.—Length, 4 mm. Body with the segments in this genus distinct. It is rather narrow and elongated, nearly three times as long as wide. The back of the body is well rounded, forming a slight arch to that of ordinary caterpillars; the segments convex, and the sutures between them deep and distinct; the dorsal region is narrower than the sides, which flare out somewhat; in transverse section the body is somewhat trapezoidal. The prothoracic segment forms a true hood, which is slightly bilobed on the front edge, and encloses the head when the latter is retracted. The head is moderately large, pale green, and the region of the mouth is darker, pale chestnut.

The three segments behind the first thoracic each bear a pair of large high pear-shaped or high conical bright pale coral-red tubercles, densely spinose and pappose. At the end of the body, on the three last segments, are three similar pairs of coral-red tubercles, those of the last pair being slenderer, more pointed, and projecting out backwards; they are also green, of the same hue as the body, but in the larger specimens they become red. Between these two sets of large red tubercles are five pairs of small green ones, which are one-third as large as the largest red ones; they are not situated quite so near together, and are all of the same size; the third pair are connected by a transverse greenish ridge; from this

ridge to the back of the second segment, or between the first pair of red tubercles is a broad, irregular patch of dull purple, interrupted between the second and third anterior red tubercles by a transverse green line.

On the posterior half of the body is a patch formed of three purplish patches connected together; the third and last of the three portions forming the patch, which ends before reaching the middle pair of the three posterior pairs of tubercles. The sides of the body fall away precipitously, spreading out a little at the base or edge of the creeping ventral disk. On this edge is a series of nine green pappose and spinose papillæ or tubercles, the anterior two or three and the last being very slightly larger than the middle ones. Between the ventro-lateral and subdorsal rows the sides are variegated with upright ridges connecting the lower and upper tubercles. The sides of the body are dark pea-green, and the dorsal region faintly yellowish green, the subdorsal papillæ being yellowish green and the lower ones dark pea-green.

In one slightly larger (4.5 mm. in length) the body above is stained less red and purple than usual, the posterior purplish patch not yet formed, and only represented by purplish points, while the third pair of anterior papillæ and the first and third pair of the posterior set are still green. Also the subdorsal line along the tubercles are whitish yellow.

It thus at this stage varies considerably in coloration and in the distinctness of the hues.

Stage IV.—Length, 7 mm. When in this stage it only differs from the smaller ones in the dorsal purplish patches being more greenish in the middle, and edged distinctly with darker and externally brighter tints. Each segment, also, covered by the purplish patches bears a pair of minute greenish warts, which are much less distinct in the smaller ones; sometimes two of these warts are connected by a greenish line. Also in this stage the last pair of dorsal papillæ are red, and the middle papillæ are stained with bright red on the inside at the base, sometimes the red stain being connected with the red border of the dorsal patch. In this and the next stage the body is somewhat higher over the thoracic region, falling away slightly posteriorly.

Last stage (V), fully grown larvæ.—Length, 12 mm. (The largest and most distinctly marked larvæ selected for description.) The body is of the same shape as before, *i. e.*, when one-half grown. The dorsal plateau is as wide as the body, the sides falling away rapidly from the edge of the plateau; the sides of the plateau are rounded over, not forming ridges. The two great patches on the yellowish plateau are pale purplish madder, darker on the edges, and edged with bright brick-red or Venetian red, while the papulæ are bright cherry or vermilion red. There is a faint, pale medio-dorsal line. The purplish patch begins on the front end of the second thoracic segment and contracts deeply between the second pair of papulæ and again between the third pair, ending suddenly in a mucronate point situated between the sixth pair of papulæ. The second patch begins at a point situated between the sixth and seventh pair of papulæ, contracts

narrowly between the ninth pair, ending just in front of and between the penultimate or tenth pair. The first patch then is composed of three sections or saddle-shaped dilatations, of which the last or third extends a little way down the sides of the plateau, and there are two divisions of the second patch, the first the larger, and extending down the sides of the plateau, but not so far as the third division of the first or anterior patch. Between the first pair of papulæ is a greenish median, transverse spot, and on each side of the first section of the purple patch are two greenish dots like a stunted exclamation mark. These dots appear to be modified surface dorsal piliferous warts, but they bear no hairs. A few fine piliferous tubercles are scattered along the sides of the body. On the middle section of the first or anterior purplish patch are four rounded, impressed, modified, greenish warts, and on the third section there are six of them. On the posterior or second patch the first and larger division bears four such round greenish spots, with a darker centre representing an aborted hair, and on the last division are two similar spots. The last two pairs of spots are connected by a faint line of the same color. The three anterior pairs of papulæ which increase in size to the third pair are all bright, delicate cherry or vermilion red. The three last pairs are of the same color, except the last pair which are green at base; of these three the middle pair (the tenth pair of all) are longest and highest, being twice as long and high as the ninth pair. The fourth and fifth pair are very small and green, while the sixth pair are somewhat larger than the two pairs in front, and the two pairs behind, and tinged with bright reddish. The papulæ are all densely spined, the spines stiff and sharp and blackish at the ends, greenish at the base. On each side, low down, is a row of nine small, spiny papulæ, rather difficult to detect as they are concolorous with the body. Directly below them are the minute, pale, circular spiracles. The papulæ are situated on a ridge, while the spiracles are just below it. Between the papulæ is a pale lemon-yellow streak. The plateau is yellowish green above and on the sides, while the sides are dark pea-green. The skin of the entire body is finely granulated.

This larvæ indicates in some points of its structure its descent and that of the group to which it belongs, from the Attacinae; these points are the setiferous tubercles, and the distinctness of the segments from one another, the sutures between them being well marked. Adoneta is one of the more generalized forms, while *Limacodes (scapha)* and *Heterogenea* seem to be the most modified, specialized or aberrant forms. Hence Adoneta, etc., are more like the probable ancestors of the group than any other genus.

Several singular microgaster cocoons occurred on some individuals, being white and projecting vertically from the back.

RECAPITULATION OF THE MORE SALIENT ONTOGENETIC FEATURES.

A. *Congenital Adaptational Features.*

1. No tubercles on the prothoracic segment.
2. The dorsal tubercles on the second and third thoracic and first, fourth, seventh and eighth abdominal segments double the size of those on the other segments, the tubercles being already differentiated at birth.
3. The prothoracic segment not yet forming a hood, the head not retracted within it so readily as in the last stages.
4. The tubercles each bear only three three-forked glandular setæ.
5. The segments are more distinct than in the later stages.
6. The body is pearly white, slightly purplish on the back.

B. *Evolution of Adaptational Features.*

1 The body in Stage II assumes nearly the form and colors of the last stage, the tubercles being armed with numerous spines, and some of them tinted with red.

2. In Stage III, the colors and appearance of the full-fed larva are assumed.

LARVA OF PHOBETRON SP.

Received from Miss Soule, of Jamaica Plain, Mass., September 10, on maple. Length, 9 mm. Anterior pair of flaps (of which there are ten pairs, five pairs being larger than the others), spreading out on each side, and as broad at the end as long; those of the four other pairs directed backwards; those of the second pair are one-half as large as the third pair, and are flattened. The fourth pair are very small; the fifth pair slightly larger than the third. The ninth pair are elongate, conical pointed and pale in hue. The tenth pair are minute, directed horizontally backwards and pale yellow. The upper surface of the body is much flattened. The color of the body is pale sandy brown, becoming paler towards the end of the body. Though young it appears to be quite different from the ordinary larva of *P. pithecium*.

The spines and hairs of *Phobetrum pithecium* present some interesting peculiarities. Fig. 11, *a*, represents one of the flaps, which is connected with the body by a very slight attachment at *a t*, situated at the base of the flattened bilobed process, which is naked beneath; the free lobe is fringed with delicate plumose hairs; *b*, represents the end of one of the smaller flaps, clothed with plumose hairs and naked at the end, which bears a very long seta; *b'*, this terminal seta, enlarged still more, with a few thick spinulate setæ near the base.

Fig. 12, two of the plumose hairs from a flap; all of the other processes have similar hairs.

The last genus of the spinose Cochliopodids is *Isa* (*Sisyrosea*). Fig. 13 represents the end of one of the lateral tubercles of the first abdominal seg-

ments of *I. (Sisyrosea) inornata*. Fig. 14, *a*, end of the same still more enlarged containing the supposed venomous glands; *b*, a group of three minute spines at the base of a tubercle, two of them containing the nuclei of the poison-cells; *c*, the basal minute spines at the base of the adjoining tubercle, with the spinulated cuticle (*d*) of the skin of the body between them; *d'*, granulations of the skin, with two minute spines and a fine hair-like seta; *d''*, portion of the cuticle, with minute forked spinules and granulations; *p*, a hollow spine filled with poison.

THE EARLY STAGES OF LIMACODES SCAPHIA HARRIS.

The young live on the under side of the leaf, eating holes out of the middle.

Stage II(?).—Length, 3 mm. On *Myrica* gale, August 4, from Miss C. E. Soule. The body is oval, much flattened compared with the full-grown larva, being of the shape of a flat-iron, the back being much depressed instead of rising into a conical dorsal ridge as in the final stage. It is square or docked in front and pointed at the end of the body. It is greenish, with a slight amber-yellow tint; but the much raised thick rim or edge of the body is stained brick-red, both the outer and inner edge of the red portion being scalloped, while a reddish bridge is thrown across the depression just in front of the middle.

Stage IV, or that before the last..—Received, August 26, from Miss Soule. Length, 6 mm.; breadth, 3 mm. The body is still much broader and flatter above than in the full-fed worm; the dorsal surface is broader than the ventral, the sides overhanging the creeping disk, while the dorsal surface is broad and depressed, the sides rising or turned up somewhat, while the sides of the body are deeply hollowed in. The body is widest in the middle where there are two large, dark blood-red patches which touch each on the median line of the body. Near the end on each side of the body (on the third or fourth segments from the pointed end of the body) are two pairs of small dark-red spots, connected at the base on the reddish rim of the dorsal field; and on the first pair of spots at the base on the edge of the body is a clear white dot which extends underneath. The edge of the dorsal depressed surface is somewhat stained irregularly with dark blood-red; the red accentuated at intervals by four or five dark-red dots. On each side of the body are two alternating series of round areas, as if stamped into the skin. On each side of the body below are two rows of somewhat similar roundish impressed spots. On each side above is a row of nine chitinous crescent-shaped marks. These spots do not differ in hue from the body. The prothoracic segment or hood is reddish in front and the shoulder of the next segment is stained with red. The head is pale green, dark around the eyes and mouth.

The specimen described below agrees exactly with Harris' figure (Corr.

Pl. iii, Fig. 8). It was found on *Vaccinium corymbosum* at Providence, October 5.

Full-fed Larva.—Length, 15 mm.; greatest height, 7 mm.; breadth of body, 8.5 mm. The body is short and high, quadrangular in transverse section, bulging out a little near the creeping disk. The back slopes rapidly down from the middle to each end, which is acute, ending in a point or process, so that the caterpillar looks like a little rough skiff. The head end is a little truncated, the head not seen from above, while the posterior end is acutely pointed and held somewhat elevated from the surface. Each side of the broad flat back is sharply ridged, and on the outside on the lateral edge of the ridge is a row of eight small, square, brownish spots. The segments are flat and continuous, the sutures obsolete, so that neither above nor on the sides is the body segmented, a characteristic of the larvæ of this genus, which as regards the caterpillar is highly modified or specialized in shape and external structure. In the middle of the back the ridge is slightly swollen and inside are two large diffuse pale-lilac patches; there is a similar pair of patches near the end of the body. The head is brown and of the usual shape. The prothoracic segment or hood has a V-shaped fissure or opening in front; it is lilac above, greenish behind. On each side of the body above is a series of faintly impressed, oblong (vertically situated) impressed areas, each containing a round pale-brown scar. There is a row of scars below the spiracles, and a row of smaller scars along the edge of the bottom of the body. There are seven round pale-brown spiracles visible; the eighth, if present, I have been as yet unable to detect.

The larva of this species differs generically from that of *Lithacodia fasciola* in the very broad dorsal plateau, which is as broad as the body, the sides being perpendicular, and either full or hollow, this being dependent on the motions of the insect. The skin is smoother, less rough and granulated than usual, and there are in general no minute setæ or fine hairs, except a few scattered hairs near the edge of the creeping disk.

The peculiar shining, glistening green color is half way in hue between the color of the upper and under side of the leaf. There is a narrow, threadlike yellow dorsal line from which a fine yellow line passes off at right angles along the suture of three of the segments near the middle of the body. On the third and fourth abdominal segments the lateral ridge, which is well pronounced, is swollen and raised, and stained yellow, but tinged with deep blood red on the top of the dorsal ridge. On the seventh abdominal segment it is flattened and hollow, and there is a subtriangular hollow, pale, yellowish brown, edged with deep red. All the four subdorsal patches resemble the small sere and brown spots on the oak leaf, which are generally yellowish brown and reddish; the imitation in color, as in other Limacodid larvæ, being striking. The edge of the creeping disk is whitish yellow. The body ends in a short, conical, tail-like process, the tip of which is brownish, and on this process the two subdorsal ridges and the two lower yellowish-white lines above the

creeping disk meet. On each side of the dorsal plateau is an alternating row of impressed areas representing flattened and otherwise modified warts, and on the sides are the spiracles, which are round and colored like parchment. Below, alternating with the spiracles, is a row of minute sunken warts, and above, also alternating with the spiracles, is a row of ten oval or dumbbell-shaped pale spots, situated on a large subtriangular impressed field. This field is seen under the microscope to be granulated, while the surface of the body around them is singularly roughened with minute raised, curved or new-moon-shaped granulations.

LARVA OF PACKARDIA ELEGANS (PACKARD).

The larvæ of this species frequently occurred on the leaves of the wild cherry at Providence, in rather dense, dark pine woods near the banks of the Seekonk river, during the last two weeks of September. The flexible tongue-like tail, reminding one of that of *Parasa fraterna*, though not perhaps homogenetic with that, is a good generic character, and it may be an incipient deterrent movable organ serving to frighten away ichneumons and tachinas.

Full-grown Larva.—Length, 14 mm.; breadth, 5.5 mm. This larva is allied to that of *Limacodes fasciola*, but differs generically in the long tail-like prolongation at the end of the body. The body is oval, but longer and narrower than usual, and rather high, with a rather narrow but well-marked median plateau-like surface bounded by well-marked, distinctly scalloped ridges, which are stained whitish lemon-yellow. From this plateau the sides of the body fall rapidly off; the surface of each lateral region or declivity is steep and somewhat hollowed, and about twice as wide as the median plateau (in *L. fasciola* the plateau is about as wide as one of the lateral regions). The sutures between the segments are indistinct, not so well marked as in *L. fasciola*. Along the middle of the plateau is a row of pale, whitish-green, rounded spots which extend nearly to the whitish ridge, and are centred by a slightly raised, dark-green spot. It does not form a tubercle or flattened wart. On each side along the middle of the lateral region is a row of ten similar spots, and farther down is a submarginal row of irregular subtriangular lemon-yellow spots, each situated directly below the dark-green centre of the whitish spots above.

The sides of the body, viz., the margin above the creeping disk, are slightly scalloped (the drawing well shows this), the points of the scallops being under a high-power Tolles triplet seen to be well emphasized by a minute piliferous tubercle, a little larger than the other granulations which roughen the skin.

The end of the median plateau is greatly prolonged into a long, tail-like, flexible, fleshy, acutely conical granulated process which is stained cherry-red above, the only red on the body. The end of the creeping disk is provided with fine short hairs.

A moth appeared in the breeding box June 6, and another June 7; it rested on the sides, with its wings depressed and the abdomen raised in the air.

Cocoon.—Rounded oval, of the usual shape; length, 6.5 mm.; shorter diameter, 4.6 mm.

My larva and also some excellent figures, with details, agree with Mr. Dyar's description of the larva of *P. elegans* in *Can. Ent.*, Dec., 1891, 277.

I have two good figures by Mr. Bridgham of the larva of *P. geminata*, which agree well with Dyar's description in *Can. Ent.*, Dec., 1891, p. 277, except that the tail is not slightly tipped with reddish. It was found on the chestnut, September 16, and also on the wild cherry.

THE PARTIAL LIFE HISTORY OF LITHACODIA FASCIOLA (HERR.-SCHAEFFER).

I am indebted to Miss Emily L. Morton for the opportunity of studying the freshly hatched larva of this species, as about the middle of June she very kindly sent me the eggs from New Windsor, N. Y., which hatched out at Brunswick, Me., July 18 or 19.

Egg.—Irregularly oval; length, 1 mm.; thin, scale-like, and the shell very thin and transparent. As they had dried on the paper on which they were laid, it is impossible to see whether the shell is marked with polygonal areas or not.*

The Freshly Hatched Larva (Fig 15).—Length, 0.8 mm. The body is white, tinged with yellowish; and the head instead of being white, as in *Adoneta* and *Empretia*, is somewhat amber colored; the eyes are black and distinct; the body is about four times as long as thick and slightly thicker through the second and third thoracic segments than elsewhere. The thoracic legs are unusually small. There are no tubercles, and the large setæ appear to arise directly from the skin; there are two dorsal and two subdorsal rows, one of each on each side. The granular setæ (Fig. 16)

* I also received from Miss Morton the eggs of *Phobetron pithecium* and of *Euclea querceti*. Like those described in this paper, they do not present good generic or specific characters, enabling them to be readily identified. I give, however, the following descriptions of them.

Egg of Phobetron pithecium.—The sexes were mated July 3. The eggs are orbicular-oval, flat, scale-like, rather large and of a more definite shape than usual; 2 x 1.5 mm.; somewhat raised in the middle, but with very thin edges, resembling a shallow plate turned bottom-side up. Some fortunately laid on glass showed very plainly that the very thin shell is covered with irregular, usually elongated polygonal markings; here and there one being one-third smaller than most of the others. As usual they are laid in an irregular group, partly overlapping each other.

Miss Morton writes me that the males seek their mates between nine and ten o'clock in the morning, and that she never succeeded in mating a captive female at any other time. She adds that the larva will feed on the chestnut, maple, hazel, oak, wild cherry, and possibly on other trees.

Egg of Euclea querceti.—Quite regular orbicular-oval in outline; thin, scale-like; 2 x 1.5 mm.; the edge is quite definite, and the polygonal areas much as in those of *Phobetron pithecium*.

are large and unusually thick and stout, and are only slightly enlarged at the base; on one side of each seta at the middle is a short, obtuse turn, just beyond which it contracts, and the blunt end is forked; the forks, however, not spreading wide apart. They are all (those of both rows) alike in shape and size and length from the second thoracic to, and including, the ninth abdominal segment, and are about one-third as long as the body is thick.

The segments are distinct, and low down is a lateral series of minute papilliform tubercles, one to each segment, and bearing a single minute short hair.

This larva is very different from those of *Empretia* and *Adoneta*, and probably is a fair type of the young or freshly hatched larvæ of *Limacodes* and *Heterogenea*.

The young larva was found feeding on the under side of a leaf of the red maple at Brunswick, Me., August 12; it also occurred on the under side of the leaf of the wild cherry in September, at Providence, and I have received it from Miss Caroline G. Soule, of Jamaica Plain, Mass., where it was found September 4, feeding on *Carya tomentosa*.

Stage III (?).—Length, 5.5 mm. The shape of the body is like an inverted skiff, the flat dorsal keel being about half as broad as the whole body, which is oval in outline, the body ending behind in a dull point, which bears two bristles. The larva is pea-green, much darker than the under side of the red maple leaf, and a little lighter than the upper side. The head is pale green, the jaws dull amber. The crenulated ridge along the back is pale straw-yellow. There is a dorsal row of about eight roundish, pale straw-yellow spots. All the tubercles, which are concolorous with the body, bear short, stiff, dark bristles. There is a row of from six to eight faint greenish-yellow rounded spots along the slope of the back, outside of the crenulated yellowish line.

Stage IV (?).—Length, 7 mm. Body oval, flattened, in general rounded; the surface elevated into a dorsal region bounded by two keel-like ridges, the edge of each being serrated, each tooth bearing two obliquely situated short spines which are green tipped with brown, the keel itself being yellowish. Along the middle of the dorsal ridge is a row of ten whitish spots with a greenish centre. Each spot is accompanied in front by two lateral white dots. Outside and below each dorsal ridge is a row of ten large white roundish spots, with dark centres; below this row is a series of white dots, and near the edge of the upper side is a row of obscure white dots. The edge of the body seen from above is scalloped, and on each scallop is a row of laterally projecting minute green spines, the largest one of which is brownish. The body in general is pale green; the head paler, dark on the mouth parts, and the eyes are dark. The surface of the body above is roughly granulated.

Several larvæ living on the under side of the leaf of the wild cherry and chestnut occurred at Providence during the middle and last of September.

Last Stage.—Length, 12 mm.; width, 6-7 mm. The body is regularly

oval in outline, rounded in front, and behind slightly produced. The head is pale pea-green, the mandibles dark, the labrum whitish. The prothoracic segment is as usual without markings. The rest of the body is divided longitudinally into three regions: There is a median, elevated plateau-like region, bounded by a well-marked irregular ridge; from this ridge the body falls off rapidly on each side to the lateral ridge overhanging the creeping disk; the surface of each lateral region may be steeply inclined or somewhat hollowed out, as it depends on the movements of the larva. The segments are defined by well-marked sutures. The skin is very rough, the soft, fleshy rugosities standing well up, and the sides of the body are finely crenulated. The body is pale pea-green, the general tint being like that of the under side of the cherry leaf, but more yellowish. The rough edge of the plateau, *i. e.*, the two parallel ridges bounding it, the surface of the plateau being level, and not hollowed, is lemon-yellow; these two lemon-yellow lines are wavy, and they connect in front on the second thoracic segment; but behind, on the last segment of the body, they do not quite meet. Along the middle of the plateau is a median series of eleven irregular roundish lemon-yellow spots centred by a depressed wart, each situated on a suture. On each segment and each side of the sutural spots, in the middle of each segment, is a pair of lemon-yellow dots. On each of the lateral slopes of the plateau are four rows of lemon-yellow spots, the highest and first being a row of minute transverse spots situated on the suture. Below this row is a series of large transverse oval yellow spots centred by a depressed dark-green point. This row is succeeded nearer the edge by a row of yellowish dots, two on each segment; one, the smaller of the two, situated on each suture. The fourth row is on the margin of the body, and is a broken series of short lines.

There is no red on the body. The end of the body is a rather narrow, obtuse, slightly upcurved portion, being the end of the dorsal plateau. There are no setæ or coarse hairs above, but around the lower edge of the body are sparsely scattered very short fine hairs. The spiracles are situated just above the edge of the creeping disk. *The dorsal setæ of the preceding stage are wanting in the final stage.*

A figure made for me, by Mr. Bridgham, of a larva found feeding by Miss Morton, September 4, on the walnut, in probably next to the last stage, represents bristles, distinct sutures, and the segments as convex, features which are not indicated in the full-fed worm.

One example was ichneumoned. It will be noticed that in its last stage this species loses its slight armature of minute bristles; and it apparently has no use for them, since I have been struck with the resemblance in the shape and color of the larva to a simple slight fold in a leaf, so much so that it might readily be mistaken for such a bend in the leaf by a passing bird; and then the very sluggish motion of the creature would further aid in the deception.

RECAPITULATION OF THE MORE SALIENT ONTOGENETIC FEATURES.

A. Congenital Adaptational Features.

1. The larva is hatched without any tubercles.
2. The glandular hairs are of the same size and shape in the dorsal and subdorsal rows; being short, with a tine at the middle, and forked at the truncated end.
3. The body is more cylindrical than in the last stages and not skiff-like, and the segments are distinct and simple.
4. The body is at first colorless.

B. Evolution of Adaptational Features.

1. The body becomes skiff-like when 5.5 mm. in length.
2. The color is pea-green, like that of the leaf it feeds on, with straw-yellowish marks and spots.
3. The skin becomes rough and granulated, and the plateau distinctly marked in Stage III or IV.
4. In the last stage the minute spines disappear.

YOUNG LARVA OF *HETEROGENEA* SP.

Very near B.'s drawing, August 8, 1888, on the wild cherry. It must be that species, as both want the anterior median reddish dorsal stripe.

My specimen, found on under side of leaf of wild cherry, September, 1890, only differs from Bridgham's figure in wanting the row of small tubercles on each side; these may be developed in the penultimate stage, but my specimen is of the same length (5.5 mm. by 3.5 mm. wide). It is closely allied to if not the same as the *Heterogenea testacea* found on the beech. It differs from those, and an unpublished figure by Emerton, however, in the line from the front edge of the second thoracic segment to the cross being obsolete, and simply represented by a faint, small, transverse discoloration, where two are represented in Bridgham's Fig. A. The red Greek cross is not very well marked, as the arms of the cross are very broad and triangular, and the base does not reach the end of the body. But the colors are as in *H. flexuosa*, the general color purple madder, with a longitudinally oblong pale Venetian-reddish patch containing still paler spots, the whole margined with deep brick-red, and edged on the outside with yellow.

This and other *Heterogeneas* look just like a reddish patch often to be seen on the under side of some of the cherry leaves and afford remarkable examples of protective coloration.

FULL-GROWN LARVA OF *HETEROGENEA* SP.

Occurred on the under side of leaf of oak at Brunswick, Me., September 6 (Bridgham's MS. Fig. 273).

Length, 9 mm.; breadth, 5 mm. The body is broad, oval, somewhat flattened, with two narrow dorsal ridges, which are a little wider apart on the second thoracic segment, and in the middle of the body. The ridges are irregular, wavy, crenulated and lemon yellow, uniting on the last abdominal segment. From the ridges the sides of the body fall away at a low angle forming a gentle declivity, on which are two alternating rows of depressed lemon-yellow oval areas, bearing a minute depressed pit, a sunken piliferous wart, without the seta. A series of scattered very minute slender short hairs can be seen with a Tolles high-power triplet. On the second thoracic segment the ridge and space between is filled with bright red; in the middle is a sunken pit, containing a small pale wart, but not bearing a bristle. A larger subtrapezoidal red spot in the middle of the body is edged with lemon-yellow, but the tubercle in its centre is stained with reddish. Besides the median warts there are nine other green ones along the middle of the dorsal ridge, one to each segment. The segments are distinct enough to be counted. The general color is pea-green, slightly more yellowish than the under side of the oak leaf. The prothoracic segment is unspotted. The head is pale greenish, the mouth parts pale chitinous. The skin of the body is in general rough and corrugated, subgranulated.

FULL-GROWN LARVA OF HETEROGENEA (TORTRICIDIA) TESTACEA PACK.

The larva (a ♂) in shape much like that of the European *Heterogenea asella*, occurred September 8, on the under side of a beech leaf, at Brunswick, Me. It spun its cocoon on September 10, and the moth appeared on May 27 following.

Larva.—Length, 11 x 6 mm. Skiff-shaped, being oval in outline, with the front full and rounded, but also rather blunt at the end, not pointed. Dorsal surface full and convex, neither angulated nor keeled, as it is in *Limacodes scapha*. On the anterior and also the posterior third of the body are two nearly parallel, slight, irregular ridges, which are not so distinct in the middle of the back, and which send out a red line, and spreading out in the middle of the body form a broad red loop nearly reaching the side of the body. The ridge at each end is a rich, bright Venetian red, edged externally with yellow. The space between these ridges is filled in with pale Indian-red almost exactly of the color of the reddish-brown withered spots on the leaves of the same tree, as I especially noticed; the mark is, in other words, a large faded reddish blotch like a Greek cross, extending from end to end of the body, the lateral triangular expansion or arms of the cross nearly reaching the sides. There is a median dorsal row of impressed rounded warts, which do not bear bristles, for there are no fine hairs or setæ on the body. From the dorsal ridges the sides of the body fall gradually away to near the edge of the body, where there is a much thickened rounded bead or ridge overhanging the edge of the creeping disk. On the sloping side are two rows

of impressed areas, the subdorsal consisting of a large transversely situated, acutely oval depression, one on each segment on each side of the body, and those of the second lower series are about one-third as large as the subdorsal ones. Low down on the side of the creeping disk is a row of small round impressed areas. In front the red top of the cross widens a good deal, ending in the front edge of the second thoracic segment; while at the end of the body, what corresponds to the foot of the cross is narrowed to an obtuse point. The skin is corrugated and somewhat granulated, and the body in general is pale green, being concolorous with the under side of the beech leaf.

On each side are two rows of depressed areas, the upper row of ten are oval, the smaller end pointing up, and the middle five on the purple madder spot or arm of the cross are longer and narrower oval than those in front or behind. The row of ten below are round sunken areas; still below, but quite near the second row, and alternating with those of the second row, is a series of ten minute button-like round depressed marks; also most distinct on the purple madder of the arms of the cross. The prothoracic segment and head are dull pea-green; the head a little paler and chitinous around the mouth-parts. The skin is rough, finely granulated and punctured, but bearing no setæ, except some sparse, minute, slender ones around the edge of the creeping disk.

The spiracles are situated just above the edge of the creeping disk.

The "frass" or castings are irregular, short, barrel-shaped pellets.

Two larvæ were found on the wild cherry in which the anterior median line is broken up into three reddish spots. In one specimen the reddish cross is much paler than usual.

(An unpublished figure by Emerton of a larva from Kittery, Me., August 27, 1867, is the same species.)

One found at Providence, on the oak, September 17, and figured by Bridgham (285), is like the one above described, but the head of the red cross is slenderer, and the whole cross is broader and larger in proportion to the body; the two arms of the cross are wider. In the middle of the body on the plateau is a square, pale, sere brown and green spot. Another specimen (Bridgham's Fig. 234) occurred September 16, on the witchhazel.

The larva of this species feeds on the under side of the leaf as do the larvæ of *Packardia elegans* and *Lithacodia fasciola*. They all eat brown patches here and there, or small holes in the leaf.

THE LARVA OF *HETEROGENEA FLEXUOSA* GROTE?

The following description was drawn up from a larva received from Mr. H. G. Dyar, of Rhinebeck, N. Y. Mr. Dyar writes: "I am not sure of the determination of *L. flexuosa*, as I never raised but one."

Length, 8 mm.; breadth, 4.5 mm. Body oval, thickest little behind the middle of the body. The median dorsal plateau is not well marked,



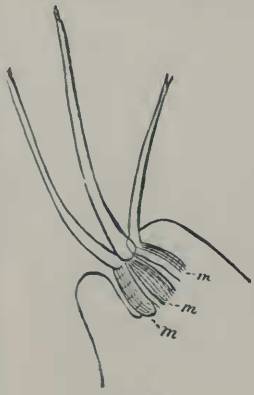


Fig. 2.

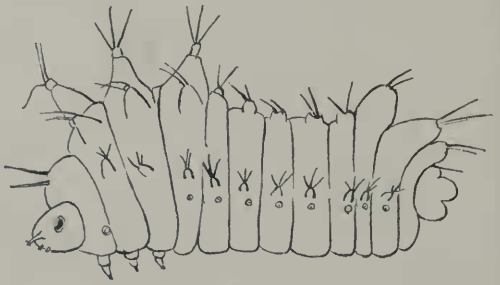


Fig. 1.



Fig. 3.



Packard del.

Fig. 4.

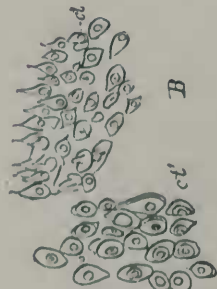


Fig. 5.